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MONITORING OF SEED AND CONE INSECT DAMAGE TO SHORTLEAF PINE AT THE OUACHITA SEED ORCHARD, MT. IDA, ARKANSAS

(1974-78)

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Abstract

Loss assessment evaluations during 1974-78 were conducted at the Ouachita Seed Orchard, Mt. Ida, Arkansas, to monitor insect damage, to assess operational effectiveness of insecticide projects and to provide information on when to apply insecticides. Results showed tip moths and unknown agents caused the most loss. Greatest losses occurred during the first year of cone development. During 1975-76, trees treated with disulfoton in March 1975 and March 1976 produced twice as much seed as trees sprayed using 4 sprays of dimethoate in 1975 and 1 spray of dimethoate and 3 sprays of azinphosmethyl in 1976. In 1976-77 numbers of sound seeds per cone were about equal in disulfoton and sprayed (dimethoate - azinphosmethyl) trees. Trees in both disulfoton and spray treatments had significantly greater numbers of sound seeds than check trees. The need to protect cones and seeds for the entire 20 month life cycle is demonstrated. Peaks in insect damage at the Ouachita Orchard appeared to be early April, mid-May and late August.

INTRODUCTION

In recent years, production of superior seed from pine seed orchards has become increasingly important (Overgaard et al. 1974). Therefore, tree improvement foresters are interested in obtaining maximum production of improved seed. However, the extent of damage to cones and seed, the agents causing damage, and the time period over which losses occur are often not known. Monitoring of cone and seed insect losses is needed to assess these factors and to determine the effectiveness of insect control projects.

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Various investigators have made short term studies of agents causing losses to cones and seed of southern pines (Ebel and Merkel 1957; Merkel 1961). Recently, several workers have studied losses on shortleaf pine, *Pinus echinata* Mill., (Franklin and Coulson 1968; Yearin and Warren 1964; Ebel and Yates 1974). The study by Ebel and Yates found that 70 percent of the total damage to cones occurred during the first year of development. Major factors were Nantucket pine tip moth, *Rhyacionia frustrana* Comstock, and abortion, possibly caused by seedbugs, *Leptoglossus corculus* Say. Major second year cone loss was attributed to coneworms (*Dioryctria* spp.), a coneborer (*Eucosma cocana* Kearfott), and midges (Cecidomyidae).

In order to determine the causal agents responsible for damaging cones, seeds, and vegetative shoots and to develop a cone life table, loss assessment evaluations were established in the Ouachita Orchard, Mt. Ida, Arkansas. The information from these evaluations was used for (1) monitoring insect-caused damage, (2) evaluating operational effectiveness of selected insecticides, (3) timing future insecticide applications, and (4) preparing biological and post-treatment evaluations. The loss assessment evaluations were conducted from 1974 through 1978.

METHODS

Loss Assessment Area 1974-75

Of the 50 shortleaf clones in the Ozark geographical source (fig. 1) in the orchard, nine clones were selected for evaluation. In January 1974, three ramets were selected from each of these nine clones. A minimum of 10 conelets were required for a tree to be selected. One hundred percent of both conelets and second year cones were tagged on each tree for a total of 2,458 conelets and 71 cones tagged. The loss assessment area was bordered by an untreated 60 foot (18.3 m) buffer strip.

Each conelet and second year cone was examined for insect damage once a month from February 1974 through October 1975, excluding September 1974. Causal agents and type damage were recorded. All cones were collected at the end of the season and subjected to a cone and seed analysis (CAS)[4/] (Bramlet et al. 1977).

This loss assessment area was not to be treated; however, it was inadvertently sprayed with dimethoate 2# ai/gal (Cygon 2E)[5/] mixed at 5.0 ml/l (4 pts/100 gals) of water as a hydraulic spray in May 1974.

[4/] This analysis provides a comprehensive analysis of the status of each potential seed, including first and second year abortions, sound seeds, malformed seeds, empty seeds, insect damaged seeds, and germination.

[5/] Use of trade names does not constitute an endorsement by the USDA Forest Service. Other products with the same ingredients may be equally effective.

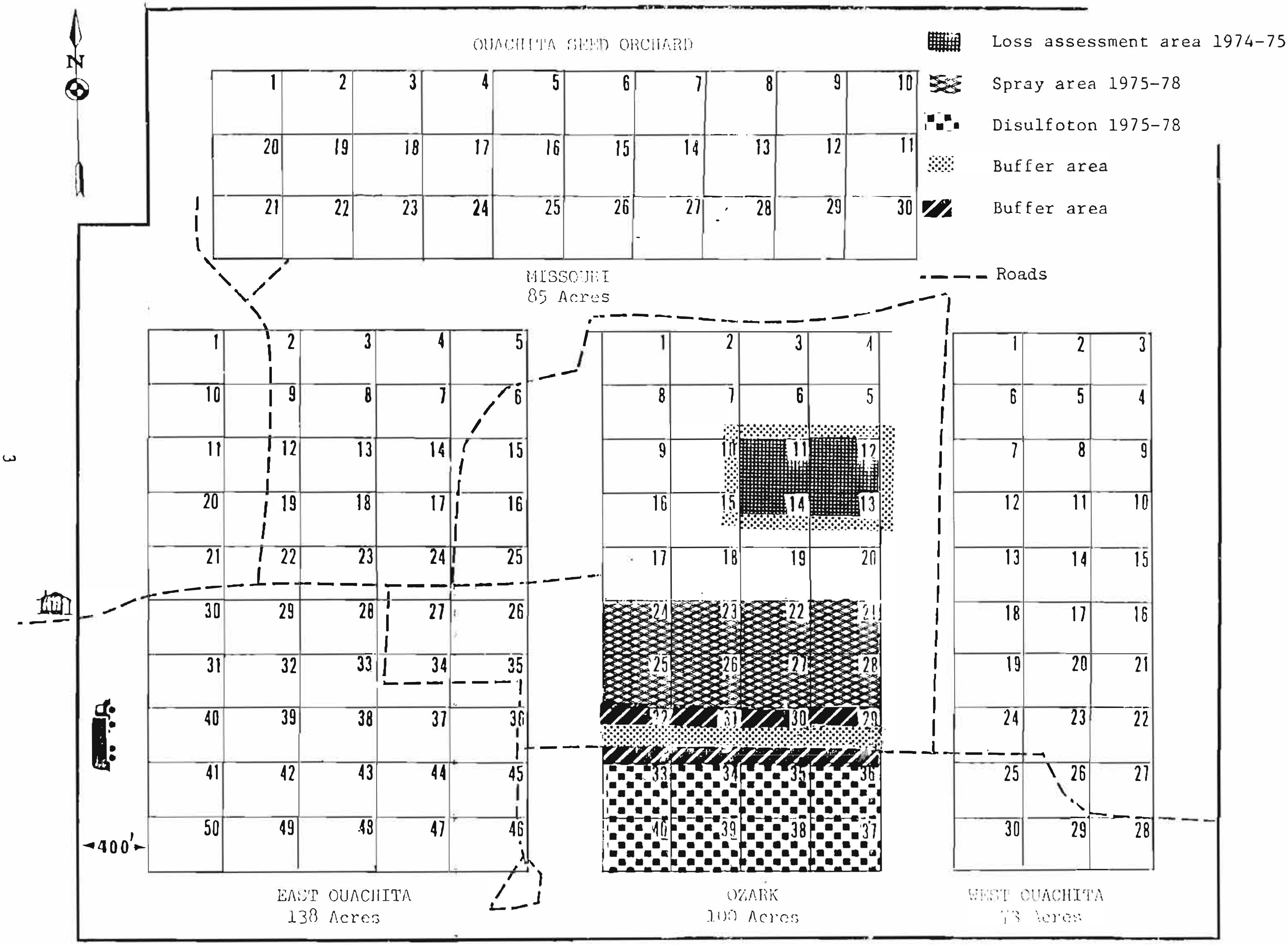

Figure 1. Map showing loss assessment and monitoring areas during 1974-1978.

Table 1. Insecticides used at the Ouachita Orchard (1975-1978).

Year	Insecticide	Rate	Equipment	Application Dates
1975	dimethoate[1/] (Cygon 2E)	5.0 ml/l (4 pts/100 gal) water	John Bean Roto Mist	4-30 to 5-9 6-12 to 6-23
	disulfoton[2/] (DiSyston)	28 g/cm (2.5 oz/in) dbh	Fertilizer spreader and disk	March
1976	dimethoate[1/]	5.0 ml/l (4 pts/100 gal) water	John Bean Roto Mist	4-5 to 4-16
	azinphosmethyl[1/] (Guthion)	7.6 ml/l (6 pts/100 gal H_2O)	John Bean Roto Mist	7-5 to 7-16 8-30 to 9-14
	disulfoton[2/]	28 g/cm (2.5 oz/in) dbh	Fertilizer spreader and disk	March
1977	azinphosmethyl[1/]	37.5 ml/l (30 pts/100 gal) H_2O	John Bean Roto Mist	May, June, July
	disulfoton[2/]	28 g/cm (2.5 oz/in) dbh	Fertilizer spreader and disk	March
1978	azinphosmethyl[1/]	37.5 ml/l (30 pts/100 gal) H_2O	John Bean Orchard Spray	May, June, July

1/ Applied to spray area on Ozark source (see map).

2/ Applied each year on an area in the Ozark source (see map).

Loss Assessment of Insecticide Treatments (1975-78)

In 1975-1978 plots for monitoring insect damage were established in check, disulfoton, and spray treatment areas. Insecticide treatments and methods of application are shown in table 1. Approximately 10 percent or a minimum of 10 conelets were tagged on two ramets of each of five clones in each treatment area. A new set of conelets was tagged each year of the evaluation and examined monthly for a 20 month period except those tagged in 1978 were examined during an eight month period.

At maturity all cones were collected from each sample ramet and examined visually for damage. Six cones were selected from each sample tree and given a CAS analysis (excluding the germination test) except in 1978 a seed orchard seed evaluation test (SOSET)[6/] was used. In August and October 1975, June and September 1976, and August 1977 the uppermost tips of all sample trees were examined for tip moth damage.

The seed potential was determined by selecting five randomly selected cones from each of two ramets of each clone in evaluation areas. All cones were dissected and the number of fertile scales counted and multiplied by 2. The seed potential for all clones in each evaluation area was averaged. The seed efficiency was determined by dividing the number of seed produced per 100 original conelets tagged by the seed potential for 100 cones.

Design and Statistical Analysis

A randomized block design was used for the evaluation with clones equaling blocks. The data were evaluated by analysis of variance and multiple range procedures. The factors were treatments, clones, and ramets. Ramets were nested within clones. Treatments were crossed with each clone/ramet combination.

The following response variables were analyzed as above for each year of the evaluation:

1. Tips damaged by tip moth

2. Conelets and cones

    a. percent tip moth losses
    b. percent coneworm losses
    c. percent unknown losses
    d. percent other losses (man caused, weather, etc.)
    e. percent total losses
    f. percent healthy

[6/] This is an evaluation of a random sample of 100 seeds that shake loose from a bulk sample of 20 to 50 cones. It gives an x-ray analysis showing percent sound seed, percent empty seed, percent seedbug damaged seed, percent seedworm damaged seed, and percent malformed seed.

3. Seed

   a. percent full seed
   b. number of full seeds/cone
   c. percent empty seed
   d. percent seedbug damage
   e. percent seedworm damage

RESULTS

Conelets

Each year greatest losses of conelets were in the unknown category (table 2). Tip moths, seedbugs, and other insects probably caused much of the loss in this category by feeding on and causing conelets to abort. The greatest identifiable loss was due to the Nantucket pine tip moth, *Rhyacionia frustrana*.

Despite the inadvertent dimethoate spray to the loss assessment area in 1974, considerable mortality occurred to conelets that year. This was due to the fact that tip moth larvae had already bored into shoots and conelets by the time the spray was applied. It is not known what effect this spray had on other insects although it was suspected as being minimal. A possibility also exists that the dimethoate caused some phytotoxicity to conelets as suspected in 1975 and 1976.

In 1975, results showed both dimethoate and disulfoton treated trees had significantly fewer conelets damaged by tip moth than the check trees. However, only disulfoton treated trees showed significantly fewer total conelets lost than check trees. In 1976, results showed only the disulfoton treatment significantly reduced total conelet losses compared to the check treatment. Another analysis showed significantly greater losses of conelets due to causes other than tip moths on dimethoate treated trees as compared with check trees as of June 1975 (Overgaard et al. 1976). Dimethoate was sprayed in April 1975 and April 1976 when young conelets were tender and open for pollination. As a consequence, the spray may have caused some flowers to abort. In 1977 both disulfoton and azinphosmethyl treated trees had significantly fewer conelets lost due to coneworms, unknown causes and all causes than check trees. Results showed that in 1977 azinphosmethyl and disulfoton treatments and in 1978 the azinphosmethyl treatment approximately doubled conelet production over the check treatment.

Mature Cones

Coneworms caused most of the damage to second year cones during the period 1975-77 (table 3). The greatest loss caused by coneworms during the 3 year period occurred in 1975 when 29 percent of the cones were damaged.

No significant difference (5% level of significance) occurred between treatments for losses to mature cones for either 1976 or 1977.

Table 2. Conelet losses on shortleaf pines at the Ouachita Seed Orchard, Mt. Ida, Ark., 1974-1978.

Flower Year	Treatment[1/][2/]	Tip Moth	Coneworm	Unknown[3/]	Other	Total Losses	Healthy
1974	Loss assessment area[4/]	46	1	40	0	87	13
1975	Dimethoate	5a[5/]	5a	73a	0a	83a	17a
	Disulfoton	1a	3a	54a	0a	58b	42a
	Check	16b	5a	59a	0a	80a	20a
1976	Dimethoate-azinphosmethyl	23a	0a	41a	0a	64a	36a
	Disulfoton	13a	0a	18a	0a	31b	69b
	Check	29a	0a	42a	0a	71a	29a
1977	Azinphosmethyl	0a	0a	27a	3a	30a	70a
	Disulfoton	0a	1a	26a	7a	34a	66a
	Check	0a	8b	49b	5a	62b	38b
1978	Azinphosmethyl	-	-	-	-	49a	51a
	Check	-	-	-	-	81b	19b

1/ For insecticide spray schedules see table 1.

2/ Based on 10% of conelets tagged on two ramets of each of five clones in each treatment in February and examined monthly through October each year, except in 1974, 100% of conelets on three ramets of each of nine cones were examined monthly.

3/ Unknown consists of those conelets aborted, dead, missing, or killed by unknown causes.

4/ Inadvertently sprayed with one application of dimethoate [2# ai/gal at the rate of 5.0 ml/1 (4 pints/100 gal) of H_2O] as a hydraulic spray i May 1974.

5/ Means not followed by the same letter are significantly different from one another at the 5 percent level of significance.

Table 3. Percent of shortleaf pine cones lost at the Ouachita Orchard 1975-1977[1/].

Mortality Year	Treatment[2/]	Percent damage by: Coneworm	Unknown	Other	Total losses
1975	Loss Assessment Area[3/]	29	8	8	45
1976	Spray	6a[4/]	8a	4a	18a
	Disulfoton '75, '76	5a	7a	1a	13a
	Check	12a	5a	7a	24a
1977	Spray '76 - disulfoton '77	5a	0a	0a	5a
	Disulfoton '76, '77	18a	0a	0a	18a
	Check	16a	0a	0a	16a

1/ Based on the number of second year cones tagged remaining on trees (3 ramets x 9 clones in 1975 and 2 ramets x 5 clones in 1976 and 1977) in February each year.

2/ For insecticide spray schedules, see table 1.

3/ Inadvertently sprayed with one application of dimethoate 2# ai/gal at the rate of 5 ml/l (4 pts/100 gal) of H_2O as a hydraulic spray in May 1974.

4/ Treatment means not followed by the same letter are significantly different from one another at 5% level of significance.

Conelet to Mature Cone Losses

The greatest losses during a 20 month period of cone development occurred on the loss assessment evaluation area during 1974-75, when 93 percent of cones were lost (table 4). Results showed that disulfoton gave significantly greater protection to conelets and cones for 20 months than check or dimethoate-azinphosmethyl spray treatments during 1975-76. Sixty-one percent loss occurred on disulfoton treated trees compared to 81 percent on check trees and 83 percent on sprayed trees.

No significant differences between treatments (spray, check or disulfoton) occurred during 1976-77 for combined total conelet and cone losses.

As a whole, much greater losses occurred to first year conelets than to second year cones. In 1976-77, treatments having fewer first year losses had greater losses the second year. For instance, check trees had 71 percent conelet losses in 1976, but only 4 percent cone losses in 1977. The disulfoton treatment had only 31 percent conelet losses in 1976, but had 45 percent cone losses in 1977. Total losses on insecticide treated trees became greater than those on check trees (although not significantly so) by the end of 1977.

Peak Periods of Conelet and Cone Damage

In 1974 and 1976, early conelet damage peaked in May and was mostly associated with the Nantucket pine tip moth feeding (fig. 2). In 1975, most of the early damage recorded in June probably occurred during May when no inspection was conducted. Most of the conelets damaged between April and June had already fallen by the time of the June inspection.

An additional peak of 18 percent conelet loss, which did not occur in 1974, was noted in October 1975. Much of this damage could have occurred anytime between August 1 and October 1 since no inspection was made between these dates. Five percent out of the total 18 percent damage was definitely attributed to coneworms, Dioryctria spp. Peak coneworm damage to second year shortleaf pine cones at the Ouachita Orchard in 1975 occurred in June and was approximately 5 percent of the tagged sample cones.

Vegetative Tips

Results showed that disulfoton and spray treatments significantly ($P = 0.05$) reduced losses of vegetative tips over check treatments in August and October 1975 and September 1976 (table 5). Losses were highest in October 1975, with 67 percent of the tips damaged in the check treatment, 37 percent in the disulfoton treatment, and 45 percent in the spray treatment. In 1976, overall damage to tips was light, with 18 percent damage to check trees in June, reduced to 8 percent in September. Damage on the disulfoton treatment was 13 percent in June versus 2 percent in September and damage on the spray treatment was 16 percent in June versus 1 percent in September. This reduction in tip damage was due to the trees putting out more young tips during the remainder of the year. No significant difference in tip damage between treatments occurred in June 1976 or August 1977.

Table 4. Table comparing first and second year cone losses at the Ouachita Orchard 1974-1976.

Year	Treatment[2/]	Percent cones lost[1/] 1st year	2nd year	Total
1974-75	Loss Assessment Area[3/]	87	6	93
1975-76	Spray[2/]	80 a[4/]	3	83 a
	Disulfoton	58 b	3	61 b
	Check	80 a	1	81 a
1976-77	Spray	64 a	20	84 a
	Disulfoton	31 b	45	76 a
	Check	71 a	4	75 a

[1/] Based on the number of cones tagged remaining on trees in February each year.

[2/] For insecticide spray schedule, see table 1.

[3/] Inadvertently sprayed with one application of dimethoate 2# ai/gal (Cygon 2E) at the rate of 5.0 ml/l (4 pts/100 gal) of H_2O as a hydraulic spray in May 1974.

[4/] Means not followed by the same letter are significantly different from one another at the 5 percent level of significance.

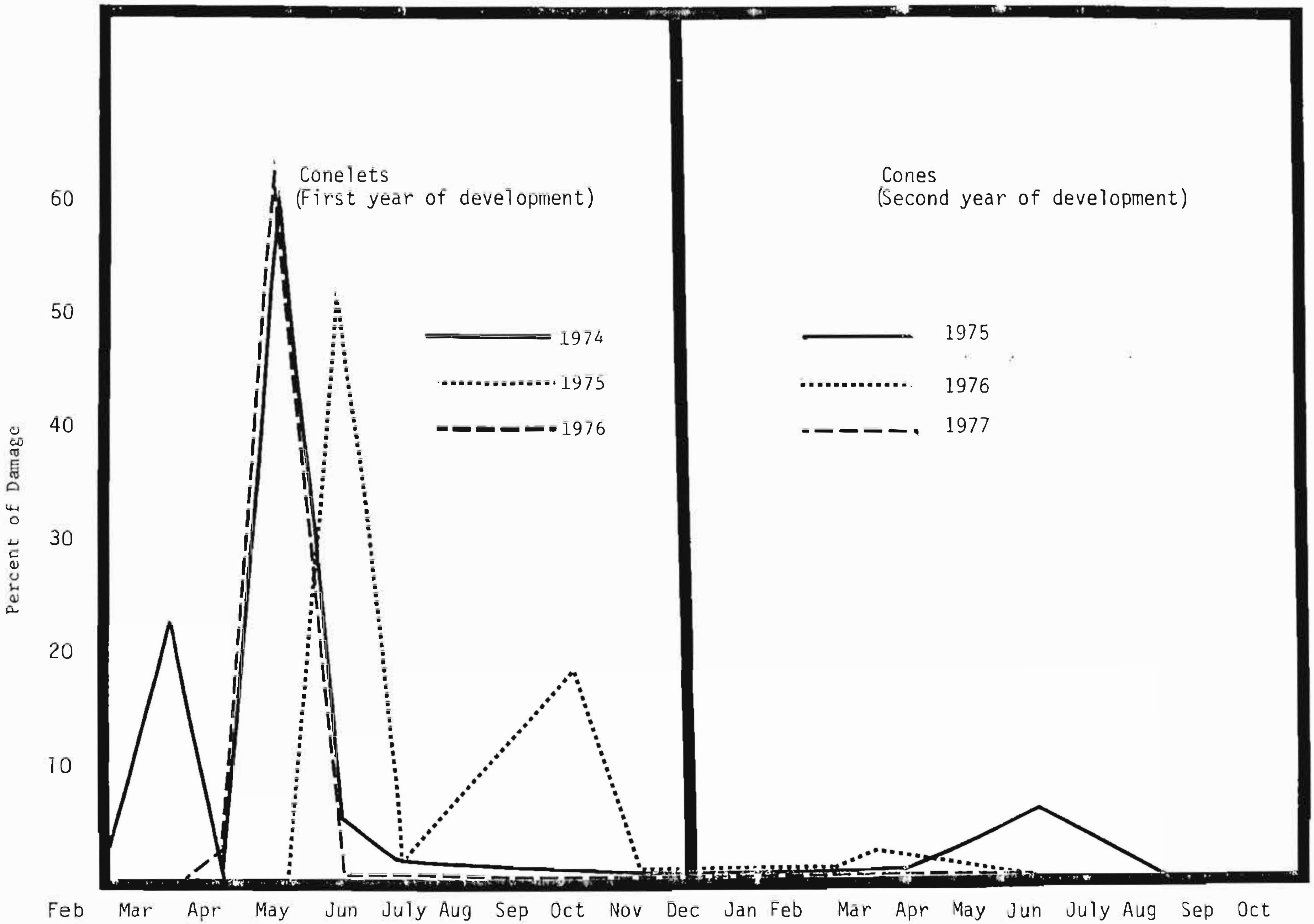

Figure 2. Percent conelet and cone losses due to all causes on untreated shortleaf pines at the Ouachita Orchard by month of inspection (February 1974 to Sept. 1977)

Table 5. Percent tip losses due to Nantucket pine tip moth on shortleaf pines at the Ouachita Orchard, Mt. Ida, Arkansas (1975-77).[1/]

Year	Month	Check	Disulfoton[2/]	Spray
1975	August	30a[3/]	7b	6b
1975	October	67a	37b	45b
1976	June	18a	13a	16a
1976	September	8a	2b	1b
1977	August	19a		9a

1/ Based on the 20 uppermost tips examined.

2/ For insecticide schedule, see table 1.

3/ Treatment means not followed by the same letter are significantly different from one another (5% level of significance).

Seed Losses

In 1976, results showed no significant difference between any of the treatments for percent full seeds, numbers of full seeds per cone and percent empty seeds; however, in 1977 both azinphosmethyl and disulfoton treated trees had significantly more percent full seeds, significantly more full seed per cone and significantly fewer empty seeds than check trees (table 6). Nevertheless, results showed a larger number of sound seeds per cone for all treatments in 1976 than 1977.

Overall Healthy Seeds Produced

Multiplying the number of cones survived (out of 100 original conelets tagged) times the number of seeds per cone produced gave the number of seeds produced per 100 original conelets.

Considering this formula as a criterion for success of treatments, in 1975-76, trees treated with dimethoate-azinphosmethyl produced 1.4 times more seed than check trees and trees treated with disulfoton produced twice as much seed as dimethoate-azinphosmethyl treated trees (table 7). In 1976-77, the disulfoton treated trees produced 5.9 times more seed than check trees and approximately the same quantity of seeds as spray treated trees. Disulfoton treated trees for 1975-76 produced the most seed during the period of the evaluation, with 24 percent seed efficiency being realized, compared with 12 percent for the spray treatment and 9 percent for the check. In 1976-77 trees treated with disulfoton and trees treated with azinphosmethyl each produced only 5 percent seed efficiency as compared to <1 percent for the check.

SUMMARY AND DISCUSSION

We found the greatest cone loss was sustained early in the first year of development (April-May). Therefore, the most important phase of protecting cones from insect attack would be during the first 2 months of development (March and April). Early damage often occurs before sprays are applied or before systemic insecticides are translocated to the foliage or cones.

As far as protecting cones for the full 20 month period of development, only disulfoton was effective and then only during 1975-76. More conelets and cones were lost on trees sprayed according to the dimethoate-azinphosmethyl spray schedule than on check trees in 1975-76 and 1976-77. When the first spray with dimethoate (April) was eliminated in 1977 and 1978 and the dosage rate of azinphosmethyl was changed from 7.5 ml/l to 37.5 ml/l, the spray treatment was effective for protecting conelets. We, therefore, suspect phytotoxicity to young conelets from early applications of dimethoate. Another reason for the greater conelet and cone loss may have been the lower dosage rate used for azinphosmethyl in 1975 and 1976.

Although disulfoton protected conelets in 1976, a 41 percent loss to second year cones occurred the next year, thereby making the total cone loss slightly higher for disulfoton treated trees than for check trees. The

Table 6. Seed losses on shortleaf pines at the Ouachita Seed Orchard, Mt. Ida, Ark., 1975-77.

Year	Treatment[2]	Percent full seed	No. of full seed/cone	Percent empty seed	Percent seedbug
1975[1]	Loss assessment area[3]	46	26	52	2
1976[4]	Spray	77a[5]	60a	18a	5a
	Disulfoton	71a	52a	29a	1a
	Check	58a	38a	39a	3a
1977[4]	Spray	59a	26a	41a	–
	Disulfoton '76, '77	39a	17a	61a	–
	Check	3b	1b	97b	–

1/ Data based on seed extracted and x-rayed from the total number of cones collected from each of three ramets of nine clones.

2/ For insecticide spray schedule, see table 1.

3/ Inadvertently sprayed with dimethoate, 2# ai/gal (5.0 ml/1) H_2O as a hydraulic spray in May 1974.

4/ Data based on seed extracted and x-rayed from the total number of sample cones that survived from each of two ramets of each of five clones.

5/ Means not followed by the same letter are significant from one another at the 5 percent level of significance.

Table 7. Seed produced from cones surviving during 2-year periods (1974-77).

Year	Treatment[1]	# Seeds produced/100 original conelets tagged	Seed potential[2] for 100 cones	Seed efficiency[3]
1974-75	Loss assessment area[4]	182 (7 x 26)[5]	9300	2
1975-76	Dimethoate ('75), azinphosmethyl ('76)	1,020 (17 x 60)	8400	12
	Disulfoton '75, '76	2,028 (39 x 52)	8400	24
	Check	722 (19 x 38)	8400	9
1976-77	Spray	416 (16 x 26)	8400	5
	Disulfoton	425 (25 x 17)	8400	5
	Check	27 (27 x 1)	8400	<1

1/ For insecticide spray schedules, see table 1.

2/ Seed potential ÷ average number of fertile scales x 2.

3/ Seed efficiency = average number of seeds produced/100 original conelets tagged ÷ the average number of seeds produced/100 cones.

4/ Inadvertently sprayed with one application of dimethoate 2# ai/gal (Cygon 2E) at the rate of (5.0 ml/l)(4 pts/100 gal) of H_2O as a hydraulic spray in May 1974.

5/ Percent cones surviving to maturity x number of sound seeds/cone.

larger cone crop surviving at the beginning of the second season on disulfoton treated trees may have caused a greater attraction for coneworms and other insects; hence, the greater loss. Since this evaluation was conducted, carbofuran has been registered for controlling coneworms and seedbugs in seed orchards and has been found effective at the Ouachita Orchard (Overgaard 1981); therefore, carbofuran should be used in lieu of disulfoton when a soil applied systemic is desired.

Protection of shortleaf pine tips from tip moth attack is important not only in preventing growth loss but in preventing loss to cone producing shoots. Disulfoton reduced tip losses caused by tip moths. Approximately 37 percent of growing tips were damaged on sample trees in this treatment block compared to 67 percent on the check trees. In 1979 (after the evaluation was concluded) visual observations showed that virtually no cones were produced in the check area used during 1975-78, whereas a much larger cone production was obtained in the remainder of the orchard. This may have been due to tip moth and other insect populations remaining high on the check area causing damage to conelets and shoots.

In summary, a good pest management program in a seed orchard should be aimed at protecting growing tips, conelets, cones, and seed for the entire 20 months of development. When insect control does not significantly reduce damage at any point in the 20 month life cycle of the cone, previous or future control efforts are worthless.

CONCLUSIONS

1. More research needs to be conducted on the reasons for abortion of first year conelets.

2. More emphasis needs to be placed on protecting first year conelets from insect attack, particularly tip moths on shortleaf pines.

3. Population sampling methods need to be developed for use in timing foliar sprays to coincide with presence of insect populations.

4. Research needs to be conducted on possible phytotoxic effects of dimethoate and azinphosmethyl insecticides on conelet abortion.

5. As a whole, disulfoton applied to the soil gave better protection to shoots, conelets, cones, and seeds than foliar sprays of dimethoate and azinphosmethyl during these evaluations; however, carbofuran should be used where a soil applied insecticide is desired. It has a specific registration for use for controlling pine coneworms and seedbugs whereas disulfoton does not.

RECOMMENDATIONS

1. Use carbofuran (10% granular) applied in February at the rate of 45.4 g/cm (4 oz/in) tree dbh instead of disulfoton since carbofuran is specifically registered for coneworm and seedbug control in seed orchards and disulfoton is not.

2. Until better methods are developed for timing foliar sprays for coneworm and seedbugs, the Ouachita Orchard should spray azinphosmethyl in early April (when conelets are closed), mid-May, and late August.

LITERATURE CITED

Bramlett, D. L., E. W. Belcher, Jr., G. L. DeBarr, G. D. Hertel, R. P. Karrfalt, C. W. Lantz, J. Miller, K. D. Ware, and Y. O. Yates III.
1977. Cone analysis of southern pines. A guidebook. SE Forest Exp. Stn., Asheville, N. C., and SE Area, S&PF, Atlanta, Ga. Genl. Tech. Rept. SE 13, 28 p.

Ebel, B. H., and E. P. Merkel.
1957. Insects destructive to flowers, cones, and seeds of slash and longleaf pine. USDA Forest Service, SE Forest Exp. Stn. Rept., 2 p.

Ebel, B. H., and H. O. Yates, III.
1974. Insect caused damage and mortality to conelets, cones, and seed of shortleaf pine. J. Econ. Entomol. 67:222-226.

Franklin, R. T., and R. N. Coulson.
1968. Insects affecting seed production of shortleaf pine in the Georgia Piedmont. Can. Entomol. 100:807-812.

Merkel, E. P.
1961. A study of losses in the 1960 slash pine cone crop. USDA Forest Service, SE Forest Exp. Stn., Res. Note 164, 2 p.

Overgaard, N. A.
1981. Post-treatment Evaluation of the Seed and Cone Insect Control Project, Ouachita Federal Seed Orchard, 1980. Rept. No. 81-2-21. Alexandria Field Office, Southeastern Area, S&PF, USDA Forest Service, Atlanta, Ga.

Overgaard, N. A., T. Flavell, and L. Drake.
1974. Seed Orchard Pest Management in the south, a problem analysis. USDA Forest Service, Southeastern Area, Atlanta, Ga. 20 p.

Overgaard, N. A., H. N. Wallace, G. D. Hertel, C. Stein, and L. E. Drake.
1976. Incidence of the Nantucket pine tip moth on shortleaf and loblolly pines in seed orchards treated with Furadan®, Cygon®, DiSyston®, and fertilizers. USDA For. Serv., SE Area, State & Private Forestry, Rept. No. 76-14. 33 p.

Yearin, W. C., and L. O. Warren.
1964. Insects of pine cones in Arkansas. J. Kan. Entomol. Soc. 37:259-264.

PRECAUTIONARY STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key out of reach of children and animals and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing.

If your hands become contaminated with a pesticide, wash them immediately with soap and water. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove the clothing immediately and wash skin thoroughly. After handling or spraying pesticides, do not eat or drink until you have washed with soap and water.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicide from equipment, do not use the same equipment for insecticides or fungicides that you used for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary landfill dump, or crush and bury them in a level, isolated place.

NOTE: Some states have restrictions on the use of certain pesticides. Check your state and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Environmental Protection Agency, consult your county agent, state extension specialist or FPM to be sure the intended use is still registered. For further information or assistance, contact Forest Pest Management, Alexandria Field Office, Pineville, La., 71360, (Telephone: FTS 497-7280, or Commercial 318/473-7280).